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BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES

Paper No. 25

Application Number: 09/476,669
Filing Date: December 30, 1999
Appellant(s): LAU, GORLEY L.

Kevin L. Daffer
For Appellant

EXAMINER'S ANSWER

This is in response to the appeal brief filed February 19, 2003.

(1) Real Party in Interest

A statement identifying the real party in interest is contained in the brief.

(2) Related Appeals and Interferences

The brief does not contain a statement identifying the related appeals and interferences which will directly affect or be directly affected by or have a bearing on the decision in the pending appeal is contained in the brief. Therefore, it is presumed that there are none. The Board, however, may exercise its discretion to require an explicit statement as to the existence of any related appeals and interferences.

(3) Status of Claims

The statement of the status of the claims contained in the brief is correct.

(4) Status of Amendments After Final

The appellant's statement of the status of amendments after final rejection contained in the brief is incorrect.

The amendment after final rejection filed on December 9, 2002 has been entered.

(5) Summary of Invention

The summary of invention contained in the brief is correct.

(6) Issues

The appellant's statement of the issues in the brief is correct.

(7) Grouping of Claims

Appellant's brief includes a statement that claims 1-11 and 30 do not stand or fall together and provides reasons as set forth in 37 CFR 1.192(c)(7) and (c)(8).

(8) Claims Appealed

The copy of the appealed claims contained in the Appendix to the brief is correct.

(9) Prior Art of Record

5,985,759	KIM	11-1999
6,045,666	SATITPUNWAYCHA	4-2000
6,217,721	XU	4-2001
5,371,042	ONG	12-1994

(10) Grounds of Rejection

The following ground(s) of rejection are applicable to the appealed claims:

Claims 1, 3-7, 11 and 30 are rejected under 35 U.S.C. 102 (e) as being anticipated by U.S. patent No. 5,985,7509 (Kim). This rejection is set forth in prior Office Action, Paper No. 19.

Kim discloses a method for fabricating a metallization structure comprising: IMP depositing a wetting layer 26 (col. 7, ll. 13-15 and col. 8, ll. 38-42), applying a bias of 0-500 W to the substrate (Table 1, in particular the portion of Table 1 continued under column 13) and sputtering depositing a bulk metal layer on the wetting layer (col. 8, ll. 38-42). A portion of the range for the bias to the substrate is identical to the wafer bias ranges applied in the instant application (see page 21, lines 25-29 for example). Therefore the portion of the substrate bias in Kim which is identical to the bias applied to the substrate is held to be a bias which is sufficient to splash deposited metal at the bottom of the cavity to sidewalls of the cavity during IMP deposition of the wetting layer (as applied to claim 1).

The bulk layer is deposited to fill the cavity (col. 11, ll. 7-10 as applied to claim 3).

The wetting layer comprises titanium (Table I and col. 14, ll. 62-63 as applied to claim 4).

Kim shows that the substrate defines a lower portion of the microelectronic topography wherein the substrate is below the dielectric layer. The multiple titanium comprising layers act as a barrier layer as well as a wetting layer over the sidewalls and bottom of the contacts (as applied to claim 5).

The IMP depositing of the wetting layer comprises directing ionized metal atoms from a target toward the dielectric layer in a direction substantially perpendicular to the dielectric layer. The target power, coil power and substrate bias in Table I-continued on column 13 provide conditions which will direct the ionized metal atoms in this manner (as applied to claim 6).

The IMP wetting layer process includes applying sufficient DC power to a target to sputter metal atoms of the target towards a substrate holder (pedestal) below the topography wherein the sputtered metal atoms comprise titanium (Table I-continued on column 13); applying sufficient RF power to an RF induction coil between the target and pedestal to ionize at least a portion of the metal ions sputtered from the target (Table I-continued on column 13 and col. 3, ll. 4-25), and applying sufficient bias to the pedestal to direct the ionized metal atoms towards the dielectric layer in a direction substantially normal to the dielectric layer (Table I-continued on column 13 as applied to claim 7).

The bulk metal layer comprises aluminum and the wetting layer comprises titanium (Table I continued on column 13 as applied to claim 11).

Kim discloses a method for fabricating a metallization structure comprising: etching contacts in the dielectric layer (col. 1, ll. 20-22, col. 7, ll. 29-38 and Fig. 1), IMP depositing a wetting layer of titanium (Table 1) and sputtering depositing a bulk metal layer on the wetting layer (col. 8, ll. 38-42 as applied to claim 30).

Claim 2 is rejected under 35 U.S.C. 103(a) as being unpatentable over Kim in view of U.S. patent No. 6,045,666 (Satitpunwaycha). This rejection is set forth in prior Office Action, Paper No. 19.

The teachings of claim 1 have been discussed above and are incorporated herein.

The difference between instant claim 2 and Kim is that Kim does not disclose depositing an insulating layer over the bulk metal layer.

Modern semiconductor integrated circuits usually involve multiple layers separated by dielectric (insulating) layers, such as of silicon dioxide or silica, often referred to simply as an oxide layer, although other materials are being considered for the dielectric. The layers are electrically interconnected by holes penetrating the intervening oxide layer which contact some underlying conductive feature. After the holes are etched, they are filled with a metal, such as aluminum, to electrically connect the bottom layer with the top layer. The generic structure is referred to as a plug. If the underlying layer is silicon or polysilicon, the plug is a contact. If the underlying layer is a metal, the plug is a via (col. 1, lines 20-32 of Satitpunwaycha).

The motivation for forming an insulating layer atop the metal layer is that it would have been used in the manufacture of IC having multiple layers.

Therefore it would have been obvious to one of ordinary skill in the art at the time the claimed invention was made to modify the teachings of Kim by forming an insulation layer atop the metal layer since it would have generated an IC having multiple layers.

Claim 8 is rejected under 35 U.S.C. 103(a) as being unpatentable over Kim in view of U.S. patent No. 6,217,721 (Xu-721). This rejection is set forth in prior Office Action, Paper No. 19.

The teachings of claim 1 have been discussed above and are incorporated herein.

The differences not yet discussed is the cavity comprising a via in the dielectric layer extending to a conductive region of the topography (claim 8).

Xu-721 shows forming an underlying metal conductive layer 310 underneath the dielectric layer and across the surface of the substrate (Fig. 17).

The motivation for providing a conductive material in the manner shown by XU-721 is that it provides improved bonding of the titanium layer(s) to the bottom of the contact.

Therefore it would have been obvious to one of ordinary skill in the art at the time the claimed invention was made to modify the teachings of Kim by providing a conductive layer of aluminum at the bottom of the contact as taught by Xu-721 since it would have improved the bonding of the titanium layer(s) to the bottom of the contact.

Claims 9 and 10 are rejected under 35 U.S.C. 103(a) as being unpatentable over Kim in view of U.S. patent No. 5,371,042 (Ong). This rejection is set forth in prior Office Action, Paper No. 19.

The teachings of claim 1 have been discussed above and are incorporated herein.

The differences not yet discussed are of precleaning the topography prior to IMP depositing the wetting layer (claim 9) and of removing an upper portion of the dielectric layer to formed tapered cavity walls (claim 10).

With respect to claim 9:

In a first process step, the contact openings are cleaned and the upper corner faceted. For openings in silicon oxide layers, sputter etching about 300 angstroms of the layer in argon plasma both removes the native oxide from the bottom of the contacts or vias and facets the corners of the openings, ensuring good intermetallic contacts as well as complete filling of the openings and the absence of any voids in the center of the filled openings. FIG. 2 illustrates a faceted contact opening (col. 3, ll. 3-11 and Fig. 2).

The motivation for providing a precleaning step is to remove contaminants from the surface upon which material is to be deposited and improve the adhesion of the deposited films to the dielectric or insulating layer.

Therefore it would have been obvious to one of ordinary skill in the art at the time the claimed invention was made to modify the teachings of Kim by providing a

precleaning step since it would have removed contaminants from the surface upon which material is to be deposited and improved the adhesion of the deposited films to the dielectric or insulating layer.

With respect to claim 10:

In a first process step, the contact openings are cleaned and the upper corner faceted. For openings in silicon oxide layers, sputter etching about 300 angstroms of the layer in argon plasma both removes the native oxide from the bottom of the contacts or vias and facets the corners of the openings, ensuring good intermetallic contacts as well as complete filling of the openings and the absence of any voids in the center of the filled openings. FIG. 2 illustrates a faceted contact opening (col. 3, ll. 3-11 and Fig. 2).

The motivation for forming facets in the upper portion of the dielectric or insulating layer is to ensure good intermetallic contact and reduce and/or eliminate the formation of voids by providing complete filling of the contacts.

Therefore it would have been obvious to one of ordinary skill in the art at the time the claimed invention was made to modify the teachings of Kim by forming facets in the upper portion of the dielectric or insulating layer since it would have ensured good intermetallic contact and reduced and/or eliminated the formation of voids by having provided complete filling of the contacts.

(11) Response to Argument

Issue A Arguments

Issue A-1: Appellant argues that Kim does not disclose a method for fabricating a metallization structure which includes applying a sufficient bias power to splash deposited metal at the bottom of a cavity to sidewalls of the cavity.

The Examiner respectfully disagrees.

First, it is noted that the claims are not limited to a particular wafer bias range or amount of splashing apart from a wafer bias being sufficient to splash deposited metal at the bottom of a cavity to sidewalls of the cavity. Thus the claims are open to any wafer bias levels which will cause at least a minute degree of splashing or more.

Second while the instant application discloses using IMP (ionized metal plasma) sputtering to deposit the titanium wetting layer under a wafer bias from 100-200 W (see page 21, ll. 20-29), there is no explicit disclosure to exclude values above and/or below this range from providing the same effect wherein at least a portion of the titanium wetting layer will splash deposited metal at the bottom of the cavity onto the sidewalls. Therefore values above and/or below the range and more particularly those bias levels above 200W are held to be sufficient to form a wetting layer while also cause splashing to occur.

Kim deposits the titanium wetting layer using IMP and conditions which are nearly identical to the ranges set forth in the instant application (see page 21, ll. 20-29 of the instant application and Table 1 of Kim) and additionally teaches of applying a wafer bias from 0-500 W during deposition. Given the fact that the process conditions are nearly identical for depositing the same material, a titanium wetting layer, and the range of 0-500 W includes the range of 100-200 W, there is a clear rationale for

expecting that at least a portion of the titanium wetting layer will splash deposited metal at the bottom of the cavity onto the sidewalls.

One of ordinary skill in the art would recognize that a 500 W bias level to the substrate would be sufficient to permit coating of the titanium wetting layer into and along each of the surfaces of the contact via (as shown in Fig. 7). In addition with a bias level of 500 W to the wafer, which is greater than the disclosed wafer bias range of the instant application, one of ordinary skill in the art would expect a bias of 500 W to be sufficient to splash deposited material at the bottom of the cavity to sidewalls of the cavity and therefore cause splashing. To establish inherency, the extrinsic evidence must make clear that the missing descriptive matter is necessarily present in the thing described in the reference, and that it would be so recognized by persons of ordinary skill. The Examiner maintains the position that the conditions of Kim as described above and in the prior art rejection of record are the extrinsic evidence which makes clear that the missing descriptive matter (splashing phenomenon) is necessarily present in the range of 0-500 W, more particularly for values inclusive and above that described in the instant application and even further at the upper limit of 500 W of Kim.

Kim further states that the titanium layer is "mostly deposited at the bottom of the contact via, rather than on the sidewalls". Thus while most of the material is deposited on the bottom, clearly a portion is deposited on the sidewalls (see col. 9, ll. 18-20 and Fig.7 which shows wetting layer 26 formed on both the bottom and sidewalls of the contact via). Kim further clearly teaches that at least a portion of deposited titanium is formed on the sidewalls.

Again it is stressed that the breadth of the claims are not exclusive to the bias ranges set forth in the instant specification nor do they specify a range or amount of splashing. Due to the apparently broad claim, in light of the teachings of Kim, the Examiner maintains the position that the prior art will inherently generate the same splashing and depositing phenomenon recited in the instant claims upon selection of a wafer bias from 0 to 500 W (more particularly 500 W being a specific data point).

Issue A-2: Appellant argues that teaching a range of bias power which is comparable to the exemplary levels cited in the Specification of the application does not necessarily teach the limitations of the presently claimed case.

The Examiner respectfully disagrees.

First, it is noted that the claims are not limited to a particular wafer bias range or amount of splashing apart from a wafer bias being sufficient to splash deposited metal at the bottom of a cavity to sidewalls of the cavity. Thus the claims are open to any wafer bias levels which will cause at least a minute degree of splashing or more.

Second while the instant application discloses using IMP (ionized metal plasma) sputtering to deposit the titanium wetting layer under a wafer bias from 100-200 W (see page 21, ll. 20-29), there is no explicit disclosure to exclude values above and/or below this range from providing the same effect wherein at least a portion of the titanium wetting layer will splash deposited metal at the bottom of the cavity onto the sidewalls. Therefore values above and/or below the range and more particularly those bias levels above 200W are held to be sufficient to form a wetting layer while also cause splashing to occur.

Kim deposits the titanium wetting layer using IMP and conditions which are nearly identical to the ranges set forth in the instant application (see page 21, ll. 20-29 of the instant application and Table 1 of Kim) and additionally teaches of applying a wafer bias from 0-500 W during deposition. Given the fact that the process conditions are nearly identical for depositing the same material, a titanium wetting layer, and the range of 0-500 W includes the range of 100-200 W, there is a clear rationale for expecting that at least a portion of the titanium wetting layer will splash deposited metal at the bottom of the cavity onto the sidewalls.

One of ordinary skill in the art would recognize that a 500 W bias level to the substrate would be sufficient to permit coating of the titanium wetting layer into and along each of the surfaces of the contact via (as shown in Fig. 7). In addition with a bias level of 500 W to the wafer, which is greater than the disclosed wafer bias range of the instant application, one of ordinary skill in the art would expect a bias of 500 W to be sufficient to splash deposited material at the bottom of the cavity to sidewalls of the cavity and therefore cause splashing. To establish inherency, the extrinsic evidence must make clear that the missing descriptive matter is necessarily present in the thing described in the reference, and that it would be so recognized by persons of ordinary skill. The Examiner maintains the position that the conditions of Kim as described above and in the prior art rejection of record are the extrinsic evidence which makes clear that the missing descriptive matter (splashing phenomenon) is necessarily present in the range of 0-500 W, more particularly for values inclusive and above that described in the instant application and even further at the upper limit of 500 W of Kim.

Again it is stressed that the breadth of the claims are not exclusive to the bias ranges set forth in the instant specification nor do they specify a range or amount of splashing. Due to the apparently broad claim, in light of the teachings of Kim, the Examiner maintains the position that the prior art will inherently generate the same splashing and depositing phenomenon recited in the instant claims upon selection of a wafer bias from 0 to 500 W (more particularly 500 W being a specific data point).

Issue A-3: Appellant argues that there is no motivation with Kim to apply a bias power which is sufficient to splash deposited metal at the bottom of the cavity to the sidewalls of the cavity.

The Examiner respectfully disagrees.

First, it is noted that the claims are not limited to a particular wafer bias range or amount of splashing apart from a wafer bias being sufficient to splash deposited metal at the bottom of a cavity to sidewalls of the cavity. Thus the claims are open to any wafer bias levels which will cause at least a minute degree of splashing or more.

Second while the instant application discloses using IMP (ionized metal plasma) sputtering to deposit the titanium wetting layer under a wafer bias from 100-200 W (see page 21, ll. 20-29), there is no explicit disclosure to exclude values above and/or below this range from providing the same effect wherein at least a portion of the titanium wetting layer will splash deposited metal at the bottom of the cavity onto the sidewalls. Therefore values above and/or below the range and more particularly those bias levels above 200W are held to be sufficient to form a wetting layer while also cause splashing to occur.

Kim deposits the titanium wetting layer using IMP and conditions which are nearly identical to the ranges set forth in the instant application (see page 21, ll. 20-29 of the instant application and Table 1 of Kim) and additionally teaches of applying a wafer bias from 0-500 W during deposition. Given the fact that the process conditions are nearly identical for depositing the same material, a titanium wetting layer, and the range of 0-500 W includes the range of 100-200 W, there is a clear rationale for expecting that at least a portion of the titanium wetting layer will splash deposited metal at the bottom of the cavity onto the sidewalls.

One of ordinary skill in the art would recognize that a 500 W bias level to the substrate would be sufficient to permit coating of the titanium wetting layer into and along each of the surfaces of the contact via (as shown in Fig. 7). In addition with a bias level of 500 W to the wafer, which is greater than the disclosed wafer bias range of the instant application, one of ordinary skill in the art would expect a bias of 500 W to be sufficient to splash deposited material at the bottom of the cavity to sidewalls of the cavity and therefore cause splashing. To establish inherency, the extrinsic evidence must make clear that the missing descriptive matter is necessarily present in the thing described in the reference, and that it would be so recognized by persons of ordinary skill. The Examiner maintains the position that the conditions of Kim as described above and in the prior art rejection of record are the extrinsic evidence which makes clear that the missing descriptive matter (splashing phenomenon) is necessarily present in the range of 0-500 W, more particularly for values inclusive and above that described in the instant application and even further at the upper limit of 500 W of Kim.

Issue A-4: Appellant argues that Kim fails to provide adequate amount of specificity with which to anticipate a bias power application which is sufficient to splash deposited metal at the bottom of a cavity to the sidewalls of the cavity.

The Examiner respectfully disagrees.

First, it is noted that the claims are not limited to a particular wafer bias range or amount of splashing apart from a wafer bias being sufficient to splash deposited metal at the bottom of a cavity to sidewalls of the cavity. Thus the claims are open to any wafer bias levels which will cause at least a minute degree of splashing or more.

Second while the instant application discloses using IMP (ionized metal plasma) sputtering to deposit the titanium wetting layer under a wafer bias from 100-200 W (see page 21, ll. 20-29), there is no explicit disclosure to exclude values above and/or below this range from providing the same effect wherein at least a portion of the titanium wetting layer will splash deposited metal at the bottom of the cavity onto the sidewalls. Therefore values above and/or below the range and more particularly those bias levels above 200W are held to be sufficient to form a wetting layer while also cause splashing to occur.

The Examiner is not persuaded by Appellants position that Kim fails to provide adequate amount of specificity with which to anticipate a bias power application which is sufficient to splash deposited metal at the bottom of a cavity to the sidewalls of the cavity since the instant claims themselves fail establish the degree of bias or degree of splashing. Thus it is equally applicable to argue that the claims lack sufficient specificity

with respect to the amount of wafer bias or splashing to be patentably distinct over the prior art of Kim.

As cited in Appellants arguments and as found in MPEP § 2131.03, "what constitutes a "sufficient specificity" is fact dependent. If the claims are directed to a narrow range, the reference teaches a broad range, and there is evidence of unexpected results within the claimed narrow range, depending on the other facts of the case, it may be reasonable to conclude that the narrow range is not disclosed with "sufficient specificity" to constitute an anticipation of the claims."

With regards to the argument to "sufficient specificity" the Examiner sets forth that the claims are not directed to a narrow range and there is no clear evidence in the specification or on the record of unexpected results for the narrower range *disclosed* (but not claimed) in the instant application in comparison to the broader range shown by Kim. Furthermore Kim teaches of a range of substrate biases (0-500W, with 500 W being a specific data point) which is considered to be sufficiently specific with respect to the claimed invention with regards to a bias power application which is sufficient to splash deposited metal at the bottom of a cavity to the sidewalls of the cavity.

Thus the argument regarding a lack of "sufficient specificity" in the prior art teachings of Kim is not held to be persuasive over the facts of the instant application and most significantly with respect to the prior art teachings applied to the instant claims.

Issue B-1: Appellant argues that Kim does not disclose ion metal depositing a wetting layer consisting essentially of titanium upon and in contact with the base

and sidewalls of the cavity within a dielectric layer and subsequently sputter depositing a bulk metal layer upon and in contact with the wetting layer.

The Examiner respectfully disagrees.

First, the transitional phrase "consisting essentially of" limits the scope of a claim to the specified materials or steps "and those that do not materially affect the basic and novel characteristic(s)" of the claimed invention. In re Herz, 537 F.2d 549, 551-52, 190 USPQ 461, 463 (CCPA 1976) (emphasis in original) (Prior art hydraulic fluid required a dispersant which appellants argued was excluded from claims limited to a functional fluid "consisting essentially of" certain components. In finding the claims did not exclude the prior art dispersant, the court noted that appellants' specification indicated the claimed composition can contain any well-known additive such as a dispersant, and there was no evidence that the presence of a dispersant would materially affect the basic and novel characteristic of the claimed invention. The prior art composition had the same basic and novel characteristic (increased oxidation resistance) as well as additional enhanced detergent and dispersant characteristics.). "A consisting essentially of' claim occupies a middle ground between closed claims that are written in a consisting of' format and fully open claims that are drafted in a comprising' format." PPG Industries v. Guardian Industries, 156 F.3d 1351, 1354, 48 USPQ2d 1351, 1353-54 (Fed. Cir. 1998). See also Atlas Powder v. E.I. duPont de Nemours & Co., 750 F.2d 1569, 224 USPQ 409 (Fed. Cir. 1984); In re Janakirama-Rao, 317 F.2d 951, 137 USPQ 893 (CCPA 1963); Water Technologies Corp. vs. Calco, Ltd., 850 F.2d 660, 7 USPQ2d 1097 (Fed. Cir. 1988). For the purposes of searching for and applying prior art under 35 U.S.C. 102 and 103, absent a clear indication in the

specification or claims of what the basic and novel characteristics actually are, "consisting essentially of" will be construed as equivalent to "comprising." See, e.g., PPG, 156 F.3d at 1355, 48 USPQ2d at 1355 ("PPG could have defined the scope of the phrase consisting essentially of' for purposes of its patent by making clear in its specification what it regarded as constituting a material change in the basic and novel characteristics of the invention."). See also In re Janakirama-Rao, 317 F.2d 951, 954, 137 USPQ 893, 895-96 (CCPA 1963). If an applicant contends that additional steps or materials in the prior art are excluded by the recitation of "consisting essentially of," applicant has the burden of showing that the introduction of additional steps or components would materially change the characteristics of applicant's invention. In re De Lajarte, 337 F.2d 870, 143 USPQ 256 (CCPA 1964). See also Ex parte Hoffman, 12 USPQ2d 1061, 1063-64 (Bd. Pat. App. & Inter. 1989) ("Although consisting essentially of' is typically used and defined in the context of compositions of matter, we find nothing intrinsically wrong with the use of such language as a modifier of method steps. . . [rendering] the claim open only for the inclusion of steps which do not materially affect the basic and novel characteristics of the claimed method. To determine the steps included versus excluded the claim must be read in light of the specification. . . . [I]t is an applicant's burden to establish that a step practiced in a prior art method is excluded from his claims by consisting essentially of' language." (see MPEP § 2111.03).

In reviewing the instant application it is evident that the wetting layer is discloses as being primarily titanium (page 16, ll. 18-24). For the purposes of searching for and applying prior art under 35 U.S.C. 102 and 103, absent a clear indication in the

specification or claims of what the basic and novel characteristics actually are, "consisting essentially of" has been construed as equivalent to "comprising."

Additionally, Kim clearly teaches of a wetting layer which is titanium (col. 8, ll. 34-42) and further that it is not desired to have reactive species (nitrogen and/or oxygen) contaminate the wetting layer (col. 2, ll. 6-24).

Therefore, contrary to Appellant's arguments, Kim is held to teach of a wetting layer consisting essentially of titanium.

Issue 2 Arguments

Issue 2-A: Appellant makes no additional argument to claim 2 apart from those arguments applied to claim 1, 3-7 and 11 as set forth in Appellants brief and discussed under the Issue 1 Arguments above, incorporated herein.

Since the Examiner maintains the rejection of claims 1, 3-7 and 11 and Appellant provides no additional arguments to the obviousness rejection of claim 2, this rejection stands.

Issue 3 Arguments

Issue 3-B: Appellant makes no additional argument to claim 8 apart from those arguments applied to claim 1, 3-7 and 11 as set forth in Appellants brief and discussed under the Issue 1 Arguments above, incorporated herein. Since the Examiner maintains the rejection of claims 1, 3-7 and 11 and Appellant provides no additional arguments to the obviousness rejection of claim 8, this rejection stands.

Issue 4 Arguments

Issue 4-C: Appellant makes no additional argument to claim 8 apart from those arguments applied to claim 1, 3-7 and 11 as set forth in Appellants brief and discussed under the Issue 1 Arguments above, incorporated herein. Since the Examiner maintains the rejection of claims 1, 3-7 and 11 and Appellant provides no additional arguments to the obviousness rejection of claim 8, this rejection stands.

For the above reasons, it is believed that the rejections should be sustained.

Respectfully submitted,

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April 24, 2003

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